XI. *On the* Ambrosinia ciliata *of Roxburgh. By the late* William Griffith, *Esq., F.L.S. &c. &c. Communicated by* R. H. Solly, *Esq., F.R.S., L.S. &c. &c.*

Read November 4th, 1845.

My attention was first directed to this extraordinary plant by Dr. Wallich in the early part of last June (1835). I must however observe, that Dr. Wallich was previously acquainted with many parts of its structure, and his artists were at the above time engaged in making a drawing of the plant, in which many of the points about to be described were represented.

A slight examination was sufficient to convince me that this plant, although referred to *Ambrosinia* by Roxburgh, did not at all agree with the characters laid down as distinctive of the original genus of that name. Dr. Wallich, to whom I had mentioned my belief that it constituted a new genus, very kindly suggested the name of *Myrioblastus*, which name I had adopted in my original manuscript. I have since however ascertained that *Ambrosinia spiralis* and *ciliata* of Roxburgh have been separated from that genus by Fischer, and together constitute his genus *Cryptocoryne*. To this Schott in the 'Meletemata Botanica' adds *Caladium ovatum* of Ventenat. Although the above separation appears judicious, yet, as very little additional light is thrown upon the plant in question, I have only to regret the inability to adopt a very classical and appropriate name.

Ord. Nat. Aroideæ.

Class. Linn. Monœcia Monandria.

Cryptocoryne, *Fischer in Schott et Endlicher Meletemata Botanica,* fasc. 1. p. 6 (charactere incompleto).

Char. Gen. *Spatha* tubo brevi ad apicem diaphragmate (septo) obliquo semipartito, limbo elongato. *Spadix* basin versus ovariis cincta, medio filiformis nuda, suprà antherifera, apice conico nudo calloso septo pilei instar tecto. *Antheræ* biloculares, transversè de-

hiscentes. *Glandulæ* 0. *Ovaria* 5–7 coalita. *Styli* 0. *Stigmata* 5–7 obliqua. *Fructus* nudus, 5–7-locularis, dehiscentiâ septicidâ. *Semina* 00, ascendentia; *testa* cellulosa, tenuissima; *albumen* nullum; *plumula* polyphylla, hilo subopposita.

Obs. Character ex *Cryptocoryne ciliatâ* omninò excerptus.

Crypt. ciliata, foliis oblongo-lanceolatis, spathæ limbo tubuloso convoluto apice dilatato oblongo-lanceolato ciliato.

CRYPTOCORYNE CILIATA, *Fisch. l. c.* (sine char.)

Ambrosinia ciliata, *Roxb. Synops. MS.*, p. 435. *Ejusdem Icon. Pict. in Hort. Bot. Calcutt. asservat.*, vol. xiii. t. 84. *Cor. Pl.* t. 262. *Fl. Indica*, vol. iii. p. 491.

A. ciliaris (Roxb.), *Spr. Syst.* iii. p. 771.

Hab. Ad ripas limosas fluminis Hooghly æstubus alternis ferè omninò submersa. Floret fructusque profert per totum ferè annum.

Rhizoma maximâ parte subterraneum, subsimplex, cylindricum, carnosum, cicatricibus foliorum infernè distantibus obliquisque supernè aggregatis et semicircularibus notatum, radiculas plures subsimplices crassitie pennæ corvinæ ad cicatrices exserens. Stolones plures (rariùs nulli) compressiusculi, elongati, hinc illinc squamis vaginantibus quarum extimæ (quoad axin) foliaceæ stipati, apicem axeos versus originem ducunt et latè radicant; plurimi rudimentarii, squamis omninò involuti, intra petiolorum bases exstant. Folia; petiolus limbi circiter longitudine, cellulosus, infra medium dilatatus et vaginans, cæterùm teretiusculus; pagina oblongo-lanceolata, acuta, apice obsoletè cucullata, integerrima, glabra, penninervis, nervo medio crasso et infrà valde prominulo: membranæ foliaceæ, obtusiusculæ, venosæ, cum foliis mixtæ occurrunt, juniores folia juniora arctè altèque amplectentes. Cilia plurima, subulata, plana, membranacea, brunnea (adultiora quasi sphacelata), erecta, ad insertiones petiolorum membranarumque utrinque uniseriatim disposita occurrunt. Spathæ in axillis foliorum solitariæ, breviusculè pedunculatæ, foliis breviores. Pedunculus compressiusculus, sub-biuncialis. Tubus brevis, compressiusculus, ad apicem processu celluloso, e sinu convolutionis originem ducente, incompleto, deorsum convexo, quasi cochleato, pilei instar spadicis apicem tegente et retinente, bipartitus. Limbus in tubum longissimum hinc sulcatum convolutus, apicem versus dilatatus in paginam obliquam, oblongo-lanceolatam, apice obsoletè cucullatam, obtusiusculam, extùs longitudinaliter venosam et cinereo-viridem, intùs fusco-purpurascentem luteo plùs minùs tinctam, processubus longis, subulatis, carnosis, sæpiùs simplicibus, aliquando 2–3-partitis, purpureo-sanguineis ciliatam; os partis tubulosæ convolutæ obliquum, albidum punctulis rubescentibus, margine crenulatâ, lutescenti-viride, parum elevatâ cinctum. Spadicis clavatæ apex

conicus, cellulosus, callosus, albus, obtusiusculus; junior cum septo coalitus; pars antherifera incrassata; media omninò nuda, gracilis, filiformis; basilaris ovariis coalitis cincta. Antheræ indefinitè plurimæ, apicem spadicis versus longitudinaliter dispositæ, sessiles, biloculares, quasi truncatæ, medio constrictæ, juniores membranâ conicâ margines thecæ truncatas insuper prominente clausæ, demùm membranâ lapsâ ore magno circulari hiantes. Pollen globosum, læve. Ovaria 5–7 (plerumque 6) circa spadicis basin verticaliter sita, inter se et cum spadice in ovarium 5–7-loculare coalita. Ovula indefinitè plurima, ascendentia, pilis cellulosis longis intermixta; foramen conspicuum hilo oppositum; tegumentum simplex. Styli 0. Stigmata 5–7 obliqua, extrorsùm spectantia, papillosa, subapiculata. Fructus nudus, breve pedunculatus, ovato-globosus, ovi circiter magnitudine, profundè latèque 5–7-sulcatus, ad apicem apiculis conicis totidem extrorsùm curvatis et stigmatum reliquiis notatus, secus sulcos in valvis totidem coriaceis, demùm revolutis, dehiscens, septis axique carnoso-fungosâ areolatâ liberis factis. Semina plura cuivis loculo, ascendentia, sub-biseriata, subovata, compressa, basi pilis inconspicuis, irregulariter sitis cincta. Tegumentum exterius (testa) cellulosum, membranaceum, tenuissimum, diaphànum, ad basin multò magis cellulosum et crassius, hinc et sæpiùs extrorsùm radiculâ perforatum: interius incompletum, callosum, urceolato-globosum, pallidè brunneum; cavitatis parte infimâ membranâ cellulosâ vestitâ. Embryo gemmiformis. Radicula brevis, conica, obliqua, vaga, sæpiùs extrorsùm spectans et testam perforans: cotyledon carnosa, nucleo ferè omninò arctè amplexa, sub fructûs dehiscentiam ad nuclei apicem constrictam amputata, parte inclusâ cum tegumentis citò separante. Plumula maxima, sæpiùs placentam versus obliquè directa, hilo obversa, polyphylla; foliolis imbricatis subulatis, apices versus deflexis, exterioribus longioribus magisque subulatis, interioribus brevioribus bases versus dilatatis, intimis folia perfectiora omninò referentibus: color præsertim interiorum viridis; apices brunnei, quasi sphacelati.

Of this genus Roxburgh has described and figured (under *Ambrosinia*) four species, *C. ciliata, spiralis, retrospiralis,* and *unilocularis*. This author describes the stigmata as glands, the naked filiform part of the spadix as style, and the conical apex of the spadix as the stigma. He still however places the genus in *Monœcia Monandria*. According to the same author, glands exist below the anthers in *C. retrospiralis*. I have observed an occasional dislocation of the anthers in *C. ciliata*, the lowermost ones being sometimes found attached at various points between the enlarged antheriferous part and the middle of the naked filiform portion of the spadix. *C. unilocularis* is, as stated by Roxburgh, remarkable for the non-existence of capsular dissepiments, the

fruit being unilocular and the placenta central, attached only by its base and apex.

In his MS. Synopsis Roxburgh says of the seeds of *C. ciliata*:—"The seed generally vegetates in the capsule, and is as completely polycotyledonous as any *Pinus*, or even *Dombeya*, the Norfolk Island Pine, itself." In his 'Flora Indica*' he describes the embryo as erect, furnished with a perisperm, and many subulate cotyledons as in *Pinus*.

I subjoin the character of the genus taken from the 'Meletemata Botanica':—

"Spatha tubo brevissimo, limbo elongato. Spadix spathæ plicâ tubum claudente (appendiculâ) conjunctus. Antheræ confertæ, loculis amplis cellulæformibus, marginatis, septo valdè distincto separatis; poro (?) dehiscentibus. Ovarium pluri- (6) loculare, ovulis diversâ altitudine axi affixis, peritropis. Styli plures (?); stigmata radiata. Semina albuminosa, testa spongiosa (?). Embryo cotyledonibus (protophyllis?) pluribus.—Asiaticæ; rhizomate stolonifero; foliis vaginâ petiolari dilatatâ, laminâ integrâ uninervi; floribus suaveolentibus."

M. Schott has referred *Caladium ovatum* of Ventenat, *Karin-Pola* of Rheede's 'Hortus Malabaricus,' vol. xi. p. 45. t. 23, to this genus. The structure of the fruit as described and figured by Rheede appears however to be somewhat different†. With this, *Arum aquaticum* of Rumph's 'Herbarium Amboinense,' vol. v. p. 312. t. 108, has no apparent affinity.

The roots are cellular and vascular in the centre, cellular towards the circumference; the intermediate part being occupied by a number of cavities (containing aëriform fluid), the walls of which are formed of a single series of cells, and which radiate from the centre. This structure seems not uncommon among *Monocotyledoneæ*. The petioles and the membraniform sheaths are arranged alternately, but corresponding in direction with each other, the

* Vol. iii. p. 492.

† In Rheede's plant there would seem to be an increased number of ovaria. From some degree of subdivision existing in the tissue of the spadix between and within the apices of the ovaria in *C. ciliata*, and in a higher degree in *C. spiralis*, as represented by Dr. Wallich's artists, I shall not be surprised if species be found to exist with ovaria disposed in two or more series; in such case their direction will most probably become more horizontal.

peduncles when present being interposed. The rudimentary stolones always correspond to the axils of every alternate sheath. In the young spadices the antheriferous portion is as it were sessile on the top of the ovaria, the filiform portion being a subsequent development. The inner surface of the convolute limb is at the same period smooth and shining. The septum is perfectly developed at a very early period, and then closes up the tube completely; it already covers, but does not adhere to the apex of the spadix, and hence the subsequent slight obliquity of the upper portion of this body. At an intermediate period the apex of the spadix adheres strongly to the septum, but subsequently regains its original free state. The septum appears to originate in a production downwards from the commencement of the division of the limb, to which part it always corresponds. The antheriferous portion is well supplied with vessels, fascicles of which pass off from the central bundles to the anthers, corresponding to the central cellular part or septum that exists between the thecæ. The anthers may from a very early period be compared to two cups joined together by their contiguous margins; the wide and open mouth which they present in their mature state being closed up originally by an extremely fine membrane, lining the cavity of the cup and forming a convexity where it closes in the opening. Within the cavity thus formed the pollen is developed. As the anther increases in size this membrane gradually assumes the form of a cone, which projects in proportion as it increases beyond the margins of the cups or thecæ. At the same time it assumes a yellow tint, by which, chiefly, I am led to think that it lines the entire cavities of the thecæ. The cellular tissue of the thecæ consists of a cutis, which is papillose on the margins of the cup, and an inner series of ovate cells arranged with their long diameters pointing from the axis. On the membrane of these cells very distinct fibres are developed, which almost always have the same direction with the cells. These fibres cross each other at very acute angles, and appear to be incomplete at either end of the cell, in which they are developed. The cone soon becomes more subulate, it remains closed, and is of a yellowish tint. The anthers appear to be fully formed at a time when the spadix is only half-developed. At a later period the apex of the cone is open, and through this opening the contents of the thecæ may be squeezed, assuming, from the comparatively small diameter of the apex of the cone, a more or less elongated

form. In the instance figured, the length to which they attained was immense. The matter squeezed out resembles exactly the process which originates from most globules of pollen, when acted on by water, and the very great length above noticed arose probably from the coalition of the processes of several granules occasioned by the pressure exerted. The opening in the cone appears to be of secondary importance; it is evident from the direction of the anthers, from the small size of the aperture, and from the relative diameters of the opening and globules of pollen, that it is not sufficient to allow of a free exit to the latter. The necessary free exit of the pollen is secured by the separation of the membrane from the inner margins of the thecæ, and at the time of fecundation the globules of pollen will be found uncovered. Although from this adaptation and the situation of the stigmata, a mere falling out of the pollen globules would apparently be sufficient to ensure their application to the female organ, yet the agency of insects appears to be very generally resorted to as an additional insurance of the completion of this important function. The lower portion of the cavity of the spatha is during impregnation found to contain many small flies, which do not appear to be able to effect their escape after having done their duty, and are after impregnation found dead within the tube.

At the earliest period at which I have examined the ovula, I have found them to be oblong bodies, projecting from the surface of the placenta, with which in structure they have a great similitude. A little below their points there is a slight constriction, the part above this being papilliform and much less grumous than that below it. At a somewhat later period, the base of the papilliform body, which is the rudiment of the nucleus, is surrounded by an annulus, a growth from that part of the ovulum situated below the constriction. This annulus is the rudiment of the integument of the ovulum; it soon increases and forms a sort of cup, beyond the edges of which the nucleus projects considerably. As the development proceeds the ovula become ovate-oblong, narrowed towards their bases and points, which are directed upwards. The nucleus soon becomes entirely inclosed in the cup, the mouth of which is then considerably narrowed: it is solid, papillose at its apex, which corresponds to the opening of the integument; its tissue appears to be more dense towards its base than at any other part. No change of any importance

occurs until after impregnation and after the withering of the spatha. The central portion of the nucleus is then much more transparent, and is evidently excavated. The shape of the cavity is clavate, the narrow extremity being contiguous to the hilum, the broader pointing to the apex of the nucleus. The opening in the integument is still conspicuous. The next step that I examined presented a considerable enlargement of the integument or testa, which had become cellular, and its cavity had assumed an irregular form. The foramen was indistinct. The nucleus had become much firmer, and its cavity much enlarged and considerably altered in shape. This cavity, which is due to excavation, as I believe is most commonly, perhaps invariably the case, extended upwards to within a very short distance of the extreme apex of the nucleus, which was apiculate; and downwards towards the hilum, the diameter being greater at its base than elsewhere. The lower portion was occupied by cellular tissue assuming the form of a sac and quite free from adhesion inferiorly. The upper third of the excavation was occupied by an oblong cellular body, the apex of which is conical. This is the young embryo; it is at the period mentioned entirely cellular, and its attachment to the nucleus is, if any, extremely slight.

When rather more advanced, the embryo is still entirely inclosed within the nucleus. It is subclavate, the conical, originally rectilinear apex has become somewhat oblique, and on one side of what may be called the head of the embryo, a depressed areola is visible. The next change presents an enlargement upwards of the excavation, which is now continued *through* the apex of the nucleus. At the same time its base has become enlarged and roundish. At this period the nucleus with its cavity resembles, not very inaptly, a Florence flask. The conical and rather oblique apex of the embryo now projects through the perforated apex of the nucleus, the inclosed part being firmly embraced by the *neck* of the nucleus, the tissue of which has become more and more callous or indurated. The next important change consists in a still greater projection of the conical apex and head of the embryo, and in the production of minute, oblong, obtuse, cellular bodies from the margins of the depressed areola. These bodies are the rudiments of the outer processes of the plumula. A little later, these marginal papillæ will be found enlarged, and at the same time additional ones will be seen developed

from the centre or disc of the areola. The obliquity of the conical apex is now considerable. The chief bulk and inclosed part of the embryo occupies at this period about the upper two-thirds of the excavation, but does not as yet extend into its lower globular portion.

As the development proceeds, the testa becomes more enlarged and more cellular, and the originally conspicuous foramen becomes more indistinct. The nucleus becomes more dense and callous, and its globular base as well as the cavity become more enlarged, and hence the more apparent constriction of its neck. The embryo as it enlarges extends downwards into the globular portion of the cavity of the nucleus, which it subsequently fills entirely. The sacciform cellular tissue previously noticed is pushed further down into the excavation as this downward growth of the embryo advances, and subsequently it forms a thin lining interposed between the globular base of the embryo and the corresponding wall of the cavity of the nucleus. The upper cylindrical portion of the inclosed part of the embryo becomes, if possible, more firmly embraced by the neck of the nucleus.

The exserted portion soon ceases to elongate, but increases much transversely. The rudimentary processes of the plumula become more and more elongated, and the extent of surface from which they are produced more and more increased. They are developed from within outwards, and subsequently become so numerous as to occupy the chief part of the periphery of the exserted and much-enlarged portion. Their growth is very rapid, and does not correspond with that of the testa, which becomes more and more thin and membranous as the processes increase in size. Owing to their greater ratio of growth, these processes subsequently become recurved towards their apices. This curvature will however be seen to commence before the processes have equalled the testa in length. The radicle keeps up a very slight corresponding ratio of growth, but its obliquity becomes increased. It always remains conical, and as from its direction it soon comes into contact with the lax, cellular, basilar portion of the testa, it becomes imbedded in it, and ends by perforating it altogether.

The fully-developed seed is oblong, somewhat compressed, depressed on its inner, convex on its outer surface, constricted towards the hilum; this portion being of a brownish tint and hard to the touch. The testa closely embraces

the plumula; it is cellular towards its base and where it surrounds the dense internal globular body, membranous throughout the rest of its extent, and so thin that the processes of the plumula are visible through it, and give to it a greenish tint. The nucleus is dense, indurated, nearly globular, the original neck having nearly disappeared. It is of a brownish tint, and contains and firmly embraces the inclosed descending portion of the embryo, which is the cotyledon. There is however partially interposed between them the lining cellular membrane, which occupies only the fundus of the cavity.

The embryo is of a singular shape. Its descending portion or cotyledon is clavate and nearly entirely inclosed within the nucleus; the inclosed part separating with that body exceedingly readily, and subsequently, about the time of dehiscence of the fruit, spontaneously. The tissue of the inclosed part is firm and more dense than the short uninclosed part. The exserted portion of the embryo consists, exclusively of the base of the cotyledon, of a fleshy, firm, plano-convex body. The plane part is depressed towards the centre, to which the base of the cotyledon is attached. From one side of this the radicle projects, which is still conical and acute, and is always directed from the placenta, and generally outwards, but often laterally, and always more or less downwards. The circumference of the convex part is entirely occupied by the processes, constituting an enormously-developed plumula. These are densely imbricated, intermixed with abortive and rudimentary ones, and of immense length, especially the outermost, which are about one inch long. They are all subulate with the exception of the two or three innermost ones, which resemble rudimentary leaves, and are divided into a limb, which is convolute, and a petiole, which is likewise convolute, the innermost inclosing in its fold an extremely minute rudimentary leaf. The outermost are the narrowest, the bases as we proceed inwards becoming gradually dilated. They are all deflexed and tortuous, especially the outer ones. Their extreme apices are invariably brown, and as it were sphacelated. The colour is green, increasing in depth as we proceed inwards, the convolute laminæ of the innermost being of a rather deep tint. These processes are furnished with vessels, but their chief bulk is cellular, the cells containing a considerable number of green globules. They are, with the exception perhaps of the outermost, furnished with stomata. These bodies however appear to be perfect in the interior

processes only. They are most abundant towards the apices of these, especially on the portion which corresponds to the lamina of the perfect leaf, and are perhaps altogether wanting towards or near their dilated bases. The cells of the cotyledon as well as of the processes of the plumula, in an early stage of their development, abound in active molecules, which have both in and out of the containing cells an exceedingly rapid oscillatory motion. It is obvious, from the universal presence of these corpuscles during the formation of tissue, that they play an important part in this most obscure process.

The processes of the plumula remain for some time entirely cellular; at an early period they have a close resemblance to the very minute leaves which exist in the axillæ of the convolute unexpanded leaves.

With regard to the elongated cellular tissue or hairs of the surface of the placentæ, which exist in such abundance in the ovarium at the time of impregnation, I have merely to add that their formation appears to be subsequent to the first appearance of the testa. They have attained a considerable size in those placentæ the ovula of which have the nucleus half-exserted. They contain active molecules, but I have not been able to detect any motion of ascent or descent. They do not disappear in the mature fruit, but are visible, arranged irregularly about the bases of the seeds.

About the time of dehiscence, or before this, on immersing the seeds in water for a short time, spontaneous separation of the cotyledon will have generally taken place about the apex of the nucleus. The truncated base of the cotyledon, after this has separated, will be seen occupying the depressed centre of the plane inferior surface of the axis. The testa will frequently be found ruptured. Yet this can scarcely be, as Roxburgh seems to think, called germination, which in this singular plant cannot be said to take place until the radicle has elongated and the innermost convolute processes have become expanded. The axis contains the rudiments of additional radicles, which, from their mode of development, may truly be said to be exserted. This I have never seen to take place before germination, as I conceive it to be limited.

I shall now pass to the consideration of the anomalous points of structure of the ovulum, particularly of those of which explanations have suggested themselves during the course of my inquiry.

With regard to the earlier stages of development I may observe, that I was aware some time before the date of these examinations of Mr. Robert Brown's opinion as to the comparatively late origin of the integuments of most ovula, and I consider the present instance as a good example of the correctness of the views of this illustrious botanist.

I have nothing to state regarding the reduction of one envelope, or the limited extent of the tegument resulting from the original nucleus; nor have I yet positively determined the nature of the cellular membrane occupying the fundus of its cavity. I am led however to think it to consist of the remains of the sac of the amnios, which so frequently line the cavity of the nucleus of other plants.

The whole of the anomalies existing in the structure of the embryo may, I think, be referred to the density of the texture of the nucleus and to the shape of its cavity.

The direction of the radicle is an instance of an exception to a very general, and, within certain limits, perhaps universal rule. I allude to the correspondence of the apex of the radicle to the same part of the nucleus, and consequently to the situation of the original opening through the coat or coats of the ovule. This exception however appears to me to be highly corroborative of the validity of the law, since in the earlier periods of development the direction is not only rectilinear, but the apex corresponds exactly with the apex of the nucleus and with the foramen*. Another circumstance is likewise to be kept in view, viz. that the law just stated is applicable only to the direction of radicles of embryos, which remain inclosed in the original nucleus, or in some modification of its original form. The perforation of the testa depends upon this anomalous direction of the radicle, and somewhat perhaps on the compressed situation of the seeds themselves.

The separation of the chief part of that portion, which is evidently from its direction the cotyledon, is most remarkable, and forms another exception to a general law. I allude to the very general *absolute* necessity of the cotyledons. I am however inclined to think from this and some other instances, that the presence of a highly developed plumula occasionally obviates this

* I would limit the expression of the above law to "radicle pointing or corresponding to the apex of the nucleus;" since there are exceptions to its correspondence with the foramen.

necessity. The separation in question appears to depend upon some constriction exerted upon the cotyledon by the apex of the nucleus.

The immense development of the plumula is the cause of the obliquity of the radicle, and appears to be intended to obviate the effect of the separation of the cotyledon: it is one among many instances of adaptation to correct what would otherwise be a destructive or fatal anomaly.

The fact of the presence of stomata on the processes of this body is extraordinary enough, particularly when it is recollected that they exist in fruits which have ripened under water.

Nothing can prove more satisfactorily than the present instance the absolute necessity of tracing anomalous forms back to the earliest periods of their development. In this case the process is attended with the desired effect, viz. of reducing the anomalies to the ordinary type of formation. It is very evident that the form of the embryo, immediately before its conical apex projects through that of the nucleus, closely resembles the usual form of these organs in other *Aroideæ*, since we have a superior radicle, a cotyledon, and a tendency to the formation of a lateral slit, as indicated by the depressed areola.

EXPLANATION OF THE PLATES.

Tab. X.

Fig. 1. Spatha of *Cryptocoryne ciliata*, cut through longitudinally, representing the spadix *in situ* and half of the septum.

Fig. 2. Spadix about the time of impregnation, and after the disappearance of the coniform membrane of the anthers.

Fig. 3. Vertical view of a pair of anthers.

Fig. 4. Theca of anther fully formed, viewed obliquely. The opening in the apex of the projecting membrane is very distinct, and through it is seen passing a grumous *boyau*-looking body of great length.

Fig. 5. Longitudinal section of one theca, showing the arrangement of its fibrous cells, and the perforation of the apex of the projecting portion of the lining membrane.

Fig. 6. Vertical view of a theca, about the period of impregnation, and after the disappearance of the coniform projection. The pollen is seen exposed.

Tab. XI.

Fig. 7. Ovule at a very early period, and before hairs are developed from the surface of the placenta: *a.* marks the site of the constriction; *b.* papilliform nucleus.

Fig. 8. Ditto, more advanced. The nucleus projects considerably beyond the margins of the cup formed by the enlargement of the annulus. The cellular hairs are now developed; some even exceeding the ovulum in length. A fascicle of vascular tissue is seen passing to the base of the ovulum.

Fig. 9. Longitudinal section of the integument of a more advanced ovulum, leaving the nucleus exposed.

Fig. 10. Ovule more advanced; the tegument is cut away as well as part of the short funicle longitudinally. The nucleus is exposed, and seen to be entirely inclosed within the tegument. It has undergone no alteration in form. Along its centre and throughout its upper half, there is an evident excavation formed.

Fig. 11. Longitudinal section of an ovule still more advanced. The irregular form of the cavity of the testa and the dilated inferior portion of that of the nucleus are distinctly visible. The embryo is still inclosed within the upper half of the cavity.

Fig. 12. Embryo, from about the same period; it is now clavate, its conical apex has become rather oblique, and on one side a depressed areola surrounded with a rather thickened margin is visible.

Fig. 13. Longitudinal section of the nucleus of a more advanced ovulum, a portion of the base of the testa remaining. The apex of the nucleus is now perforated, and the lower portion of the cavity is still more enlarged, and is seen to be occupied by cellular membrane. The conical apex of the embryo is seen projecting beyond the apex of the nucleus.

Fig. 14. Nucleus, with portion of the base of the testa, still further advanced. The now enlarged apex of the embryo is seen projecting beyond the nucleus, and the original conical apex has become more oblique. From the areola two teeth are seen to project; these are the rudiments of the outer processes of the plumula. The apex of the inclosed portion has now reached to the dilated part of the cavity.

Fig. 15. Embryo from the same placenta but from another ovule. The radicle is more oblique, and the rudimentary processes, of which there are six, are more enlarged; none are developed from the centre of the areola.

Fig. 16. A much more advanced ovule. The greater part of the testa is cut away; the nucleus and enlarged apex of the embryo are exposed; the radicle still preserves its obliquely ascending direction, and there is still some degree of obliquity in the plumula.

TAB. XII.

Fig. 17. Ovule nearly perfectly developed, outer face.

Fig. 18. Ditto, longitudinal section. The testa is seen to be cellular where it surrounds the nucleus, almost membranous and diaphanous where it is in apposition with the plumula. The nucleus is seen closely embracing the cotyledon. The section of the exserted portion of the embryo presents a fleshy mass; the plumulary processes are already highly developed, and have already assumed a greenish tint, especially the innermost: they are longer than the testa.

Fig. 19. Capsule shortly after dehiscence and before the valves have become revolute. The dissepiments are attached to the free central placenta. Several ovula are visible lying on the inner faces of the valves.

Fig. 20. Transverse section of a capsule before dehiscence:—natural size.

Fig. 21. Fully developed embryo, detached. This must be done with care, as the cotyledon separates very readily: *a.* the subglobular pisiform cotyledon; *b.* the radicle; *c.* the enormous plumula.

Fig. 22. Seed, the testa of which has become ruptured, and in which the separation of the cotyledon has taken place. The nucleus is seen forming a globular brownish body near the hilum.

Fig. 23. Longitudinal section of the testa and nucleus of a seed after the separation of the cotyledon has taken place. The cavity of the nucleus is seen to be filled with the separated portion of the fleshy firm cotyledon.

Fig. 24. Embryo, a short time after the separation of the cotyledon; the inner processes have begun to be expanded, and an accessory radicle is formed. This represents the first period of germination.